Addendum #1

Documentation of Stakeholder Involvement

A National Roadmap for Vadose Zone Science & Technology

IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

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1.0 Introduction

The *Preliminary Stakeholder Involvement Work Plan for the DOE Complex-Wide Vadose Zone Science & Technology Roadmap* was developed by subcontractors EnviroCom and Global Environment Technology Foundation (GETF) in December 2000 as a guidance tool to establish communication channels between interested stakeholders and the INEEL Roadmap project team. In the process of supporting a fairly aggressive outreach effort for such a technical planning document, the Department of Energy (DOE) has demonstrated its commitment to involving a variety of stakeholders in the emerging National Vadose Zone Initiative.

Substantial comments were received from individuals who attended 19 meetings involving stakeholder groups between February and July 2001. Written comments received during this period also have been analyzed with relevant excerpts provided in appropriate sections of this report. All those comments received prior to May 15 were considered by the Executive Committee in the revision of the newly revised roadmap, Revision 0.0, Draft 5. Because this report documents the full extent and nature of public input received during the review process, it should serve as an official addendum to *A National Roadmap for Vadose Zone Science & Technology: Understanding, Monitoring, and Predicting Subsurface Contaminant Fate and Transport in the Unsaturated Zone,* dated August 2001, DOE/ID - 10871.

2.0 Elements of Stakeholder Outreach

2.1 Initial Stakeholder Identification

The primary tactical approach for involving stakeholders in the National Vadose Zone Program called for a series of informational briefings, forums and roundtable discussions to introduce the draft roadmap to interested groups, determine the nature of stakeholder interest, and identify questions and concerns associated with the project. Contact was also made through attendance at various workshops and conferences where the Vadose Zone Roadmap was introduced to receptive audiences.

The Roadmap team identified a range of prospective stakeholder groups, and contact was made with those most likely to entertain a briefing or cosponsor informational roundtable discussions with their constituencies. Among those approached were intergovernmental associations, DOE site-specific advisory boards, technical and professional associations, academic interests, nonprofit organizations, and Federal agencies. At their own discretion, a few organizations declined hosting a briefing or a roundtable discussion. Upon declining, the common explanation given was their need to direct limited resources to immediate, short-term issues, rather than to programs with a long-term focus such as vadose zone research. One scheduled roundtable for private sector interests was cancelled due to inadequate pre-registration, an indicator that interest in vadose zone research and technology development may be limited to site-specific knowledge or concerns.

2.2 Stakeholder Outreach Events

Federal Facility Leadership Council – Washington D.C. – January 30. Presentation by Gerald Boyd, DOE-HQ, to over 60 senior EPA officials.

Long-Term Stewardship Subcommittee of the ECOS/DOE Forum – Tampa, Florida – February 27. Presentation by Gerald Boyd, DOE-HQ to attendees from multiple states.

EPA Region IV – Atlanta, GA – March 13. Fourteen people attended this preliminary planning session including Frank Parker and Steve Kowall, INEEL Program Manager, and key EPA & DOE officials from southern states. A commitment was made to host an all-day roundtable/forum on May 23, 2001.

Idaho Department of Environmental Quality – Boise, Idaho – March 20. Briefing by Clay Nichols, DOE-ID and Steve Kowall, INEEL, that included two Congressional staffers, Governor Kempthorne's representative and four DEQ staff.

INEEL Citizen's Advisory Board – Boise, Idaho – March 21. Approximately 25 board members and observers heard DOE-ID Clay Nichols' and INEEL Steve Kowall's 45-minute Roadmap briefing.

Boise State University Geology Class – Boise, Idaho – March 21. This was an impromptu presentation to graduate students on vadose zone issues and processes by Clay Nichols, DOE-ID, and Steve Kowall, INEEL.

Hanford Advisory Board – Richland, Washington – April 9. Complete six-hour roundtable event with 41 attendees from a variety of local, state and federal agencies, public and tribal interests, two DOE citizen advisory boards, interested contractors and seven Roadmap team members.

National Governors Association, Federal Facilities Task Force – Washington D.C., April 12. An audience of 30 state and federal agency representatives was present for a 30-minute briefing of the task force by Skip Chamberlain, DOE-HQ, and Steve Kowall.

National Council of University Research Administrators – Santa Fe, New Mexico – April 17. A workshop held as part of their annual spring conference was attended by only three interested persons, a reflection of low interest in the topic and generally poor attendance of all the late afternoon sessions.

Snowbird Technical Conference – Snowbird, Utah – April 24. About 100 federal agency and contractor representatives heard Steve Kowall's 20-minute presentation.

Executive Board of the Interstate Technology Regulatory Committee (ITRC) – Snowbird, Utah – April 25. The group included Executive Director Rick Tomlinson and representatives from three states.

EPA Federal Work Group - San Diego, CA – May 7-8 . Vadose Zone Roadmap was part of a two-hour workshop on long-term stewardship presented some 70 state and federal technical staff in the fields of geosciences, engineering and oversight of federal facilities. Clay Nichols (DOE-ID) and Executive Committee members Rien van Gunuchten and Lorne Everett were in attendance.

Subsurface Contamination Focus Area - Savannah River Site - Atlanta, GA - May 22. Briefing for DOE and SRS contractors who are involved in the development of subsurface technology applications. Steve Kowall and Clay Nichols were in attendance.

Regulatory Stakeholder Forum - *Cosponsored by U.S. EPA and U.S. DOE* - Atlanta, GA - May 23. Some 43 people were in attendance for the six-hour session including state regulators, DOE site managers and support staff, and EPA R&D program officials from the national office plus local management staff.

Regulatory Stakeholder Forum - *Cosponsored by U.S. EPA and U.S. DOE* - Seattle, WA - June 6. There were 31 attendees for this six hour meeting including state regulators, tribal and university representatives, members of the Vadose Zone Executive Committee, EPA national and regional officials, DOE national and Idaho officials, and contractors.

Inland Northwest Research Alliance – *Board Briefing* – Idaho Falls, ID – June 7. Seven universities were represented along with INRA staff. Stephen Kowall was the presenter.

Desert Research Institute – Las Vegas, NV, June 20. Steve Kowall discussed detailed comments received from the Desert Research Institute and DOE-NVO.

Association of State Geologists - Fairmont Hot Springs, MT - June 26. Clay Nichols, DOE-ID, presented a brief summary of Roadmap activities to ascertain interest on the part of the scientific community represented at the meeting.

Unsaturated Zone Interest Group (U.S.G.S.) – Idaho Falls, ID – July 31. Steve Kowall delivered a 20-minute presentation to the 150 assembled scientists.

It should be noted that the all-day meeting formats used for the Hanford Advisory Board roundtable and the two EPA-DOE regulatory forums allowed for significant participant interaction and thus yielded more detailed feedback than normally received at official briefings or conference workshops. The featured individual presentations allowed time for extensive Q&A, and the small group discussions were designed to maximize participant input. The all-day format also permitted time for group critique of each event and insightful summary statements by agency officials.

2.3 Web Site and Written Materials

The National Vadose Zone Program established its own Web page in December 2000 as part of INEEL's general Web site. Included was a description of the roadmap development process, a listing of the 62 participants in the roadmap workgroups, bios of the Executive Committee members, and the complete text of the draft roadmap document. A simple, two-page fact sheet was developed in January 2001 for use in stakeholder outreach, and the text was also posted on the Web site. Currently the site address is: www.inel.gov/vadosezone and it has received 52,380 hits and 31,383 page views as of May 2001. In addition, over 300 printed documents have been distributed to those requesting it.

3.0 Summary Observations on the Draft Roadmap and its Future Implementation

The briefings, workshops, forums and roundtable discussions held to date have garnered significant insights from stakeholders representing a diversity of interests. Overall, the comments generally have been supportive and constructive in critique. In seeking input on the draft DOE Complex-wide Vadose Zone S&T Roadmap, the INEEL team and Executive Committee members expected that comments would not be restricted to the document itself nor only to the technical details embodied within the text. Indeed, most feedback received from the 17 stakeholder events was institutional rather than technical in nature and focused mainly on the following areas:

- The process of Roadmap development, setting priorities and gaining necessary funding for future implementation
- Forming constructive partnerships for the future with scientists, states and other Federal agencies
- The need for accurate information and improving public involvement through the implementation phase
- Specific feedback on the Roadmap's proposed research agenda and needed remediation technologies.
- The need for continued regulatory compliance and addressing site-specific cleanup priorities.

It will be critical in the final Roadmap revision to clarify where vadose zone research lands in the context of other DOE and other Federal programs, particularly with the national emphasis in its title. It is likely that the proposed research will be advanced as part of DOE's Long-Term Stewardship program, although shared ownership by other agencies will be desirable. It should be remembered that event participants expressed a strong desire for meaningful, comprehensive research and practical guidance for program implementation. There is an expectation that the Roadmap will be used to resolve informational and guidance gaps and overlaps between and among programs and policies.

Common to each event was the candid recognition by speakers and participants of the uncertainty associated with contaminant behavior in the vadose zone. Miscalculation of contaminant fate and transport at the Hanford Site was identified as the primary driver behind the Roadmap effort, although the likelihood of similar surprises at other DOE sites was also recognized. Event participants shared how they believe this uncertainty is hampering the nation's ability to move forward with confidence toward cost-effective remediation of radioactive and hazardous waste, much less acceptance of long-term stewardship at DOE sites with residual problems. The stakeholders emphasized their concern for the long-term health of the nation's limited groundwater supplies, which currently supply drinking water to 50% of the U.S. population. In response, the Executive Committee directed that groundwater protection be identified as a primary motivator for moving forward with the research described in the revised roadmap.

The DOE's willingness to partner with other agencies and entities to explore the vadose zone has been welcomed by participants. This unified approach underscores the importance of the program and sets the stage for knowledge and products that can be practically applied within many sectors of society. With the benefit of input from multiple agencies and stakeholders, research projects should be designed to better address site-specific needs. Consequently, policymakers will be better able to make decisions when the research and development results have already taken in account the broad array of agency and stakeholder concerns.

It is anticipated that the relationships formed through this initial stakeholder outreach will endure well into Roadmap implementation. Future outreach efforts should build on these initial contacts and incorporate additional stakeholder groups as proposed research is funded and moves forward. While the Roadmap is a science and technology-based document, stakeholders expressed a desire for the document to be accessible and friendly to non-researchers. The implication is that there should be a general awareness of vadose zone research among a diversity of stakeholders, and such awareness will only be generated through ready access to user-friendly information.

A primary concern expressed by many participants is the need for the research to be tied to specific site needs and applications. The participants expressed a need for research and development that encompasses the large issues and still provides for field applications under specific site conditions. The stakeholders at the sites want to be certain that the Vadose Zone program provides well-defined guidance, with schedules and compliance requirements that are consistent with other programs. Site representatives urged the program to be relevant to their specific needs and help provide adequate resources that will enable them to fully perform their activities.

The participants noted that vadose zone research has the potential to lend increased confidence to the regulatory decision making process, but there was a frustration about waiting to act until research could be completed. It was expressed that, while the research could be valuable, the public wants to see immediate action on cleanup. The participants' comments reflect an eagerness for research that delivers tangible results, rather than issuing documents that just go on the shelf. DOE stressed that this was an opportunity to assure compliance and identify other areas where new knowledge can be applied. By working closely with DOE, state and Federal regulators can help ensure that there will be maximum benefit from the research dollars expended.

The briefings and roundtable discussions have helped craft improvements to the Roadmap that will make the document more relevant to stakeholders across the country. Early success in demonstrating the national relevancy of the proposed research and continued agency and public involvement should help in securing continued funding and political support. While expanding the knowledge base so critical to understanding the vadose zone, the National Roadmap will also serve as the mechanism to facilitate more effective remediation and stewardship activities at contaminated sites across America.

4.0 Detailed Comments from all Sources

Specific input received from letters, presentations and event discussions have been grouped into major categories in this section for ease in reading and understanding. The source of each comment has not been identified to allow for unbiased review.

4.1 Roadmap Development and Implementation

4.1.1 Roadmap Organization and Approach

- The Roadmap is impressive, comprehensive, and well thought out.
- The most important fate and transport research is covered; however, the 25-year timeframe is unrealistic.
- The Roadmap is designed to provide incremental improvements over time, and to be used as a strategic thinking tool.
- We recommend that the vision statement in the Roadmap be improved and that research opportunities be identified across a number of program areas where such research would be beneficial.
- Need to better define the project management level and approach to the Vadose Zone roadmap, the decision support systems, and the tools that will be available to support the roadmap implementation.
- The Roadmap is designed to be a working system for all stakeholders. However, science cannot necessarily answer the question of what constitutes enough information, or how success is defined.
- In the future what will the roadmap committees do and how can others become more fully engaged? Before implementing, these issues should be defined.
- It was acknowledged that the Roadmap would help identify "how we get there from here," and would help assess uncertainty, but not eliminate risk.
- Deliverables should be actual products, not milestones or reports.
- Why was the vadose zone issue only uncovered now? Make clear the future consequences of having little action without the Roadmap and needed research.
- Consider that the first Roadmap document was considered to be a "DOE Document". The next iteration should be the "national document," and developed as a guide for future roadmaps with a national scope.

- There should be a concentrated balance in the design of the Roadmap between "getting the job done" and the science and technology requirements

- Since research does not move in a defined schedule, we need to ensure that the best decisions are being made to work on today's problems and not assume that we will have solutions in 25 years. One way to do that is to make sure that the Roadmap is tied to cleanup milestones and long-term stewardship.

- Need the ability to provide the appropriate solution at the right time. How can we better define the "right time" with regard to cost, schedules and milestones that drive the program.

4.1.2 DOE Program Structure and Integration

- How do all EM 50 programs fit together with the Roadmap? The Roadmap should include how everything fits together to help any given site.

- The Roadmap must present a unified approach. It will help the Vadose Zone program to have the ability to integrate data and fill in the knowledge gaps.

- I now have a better understanding from the Roadmap of what the Vadose Zone Program is and where it is going.

- There appears to be barriers with DOE itself – how does DOE propose to overcome these barriers with regard to implementation of the Roadmap?

- The proposed vadose zone research is long-term issue, whereas short-term issues have traditionally led R&D.

- Is the "contamination problem" just being moved to the vadose zone through the Roadmap initiative?

- Vadose Zone Program should be considered with groundwater, subsurface and long-term stewardship.

- Why and how was the VZ Roadmap linked to the Long-Term Stewardship efforts? Everyone needs to obtain a better understanding of the relationship of VZ and LTS programs.

- Roadmap seems more geared toward LTS, rather than cleanup; public policy for cleanup and LTS is equal in importance to R&D

4.1.3 Establishing Research Priorities

- How will sites be prioritized regarding spending, implementation, and integration with compliance and cleanup requirements? You need to develop a prioritization criteria/approach.

- Should requirements need to change over time, this should be noted in Roadmap schedules and decisions.

- A strategy needs to be defined more clearly for the progression of short and long term needs.

- What are the most effective ways to measure short and long-term performance?

- Develop a path to resolve the paradox of the long-term view versus the need for short-term results. How will the Roadmap address short and long-term needs?

- Develop a decision tree (decisions systems process) to determine if the Vadose Zone is significant or important at a site.

- We recommend that prioritization tradeoffs be made given the extensive research requirements, and that the 25-year period be examined to focus in more on short term implementation benchmarks and measures. Consider identifying short vs. long term requirements, site specific issues, enabling technologies, three top research needs, and national overarching issues.

- Prioritizing the work will be very challenging, especially given the closure of many sites in the next 25 years and under conditions of potentially unacceptable uncertainty. LTS strategies for managing waste sites need to consider which components of closure systems could be subject to modification. Adaptive management approaches have not typically been used for environmental cleanup. Recent advances in adaptive management for watersheds and water use allocation could be evaluated for their lessons on implementing this roadmap in parallel with site closures in the DOE complex.

- *There is no prioritization of investigations.* This is a sticky issue because the assignment of priority needs can easily become a dogma on how to do science according to the few individuals who develop the priorities. On the other hand, awareness of a collective vision among the research community should probably be organized so that, for example, a disproportionate amount of resources are not spent on developing a better TDR probe to measure tens of cm while cutting into resources for advancing in the next generation of instruments for enhanced seismic tomography. As a second example, if progress is made in renormalizing and upscaling hydraulic properties, a complete understanding of fundamental pore-level processes may not be required for effective remediation, and therefore fewer resources need to be allocated

to it. If, however, little progress is made in upscaling hydraulic properties, then pore-level processes will become important, as they will be built into simulators that model all of the physics over a much broader range of spatial scales.

The following are some potential approaches to prioritizing vadose zone research:

- Evaluating science and technology needs developed by the Office of Science and the Environmental Management Office of Science and Technology for different sites.
- Evaluating areas of uncertainty identified in performance assessments conducted for closure sites across the complex. Areas of uncertainty in common at many disposal sites could become a research priority. This approach is being used this year to prioritize future vadose zone characterization at sites managed by DOE/NV.
- Evaluating the schedule for closure of sites with significant percentages of the total inventory of radiological and other contaminants across the DOE complex. Using this approach, addressing the needs associated with these sites as priorities, it could be argued that this approach would have the greatest cost/benefit risk reduction on a national scale.

4.1.4 Funding for Implementation

- The proposed research exceeds what likely can be funded.
- How can the Vadose Zone research be planned when the federal funding for OST is to be cut 20% from FY 01 to FY 02 (252mm to 196mm)?
- What will be the VZ funding source? Will there be an opportunity for other agencies to participate in funding research projects?
- The funding required to achieve the markers in the Roadmap may be too ambitious – how will that be addressed?
- From a state perspective, what are U.S. DOE and U.S. EPA able to fund to support the Vadose Zone roadmap effort, and what role will states be expected to play?
- How will the research ”end point” be determined and how will the research and development effort be funded for the vadose zone initiative?
- Is there a process for determining how and where limited money will be spent and how will this translate into research and site closure decision making over 25 years?

- Can the EPA not be burdened with additional DOE initiatives, but share in the effort of studies/research/compliance with regard to budget and other resource commitments?

- The most cost-effective path to cleanup and LTS will only be found if the purpose and promise of the research is recognized.

- Implementation of the Roadmap must be geared to the funding authorities, the RFPs, federal managers and must have multi-agency perspective to be useable.

- The process should be transparent, especially regarding the opportunity for scientists to bid on the research grants they propose.

- We can improve the success of vadose zone research by realizing economies of scale by addressing the needs of other programs (RCRA, UST) in addition to cleanup. We should also mine existing data to improve our knowledge of the vadose zone.

- It will be important for States, Tribes and other Federal agencies have input and influence into the proposed Vadose Zone research budget. Also, industry and local governments need to be given an opportunity to work with the Federal and state partners to resolve common problems relating to the Vadose Zone.

4.2 Developing Partnerships for the Future

4.2.1 Federal Partnerships

- Partnering is critical to identify national priorities and help with implementation.

- In order to achieve partnering, there needs to be a shared vision, improved understanding by the public of the "critical" importance of vadose zone issues, and potential benefits to each partner.

- Clearly identify the partners who will be involved in the Vadose Zone Roadmap research efforts – how they will be chosen, etc.? Similarly, identify the key players from the different sites that will have the opportunity to participate in the roadmap.

- Need to better consolidate lessons learned among other agencies and work toward successful implementation of the Roadmap.

- Initiate a framework for continuous interaction: within the DOE, with other agencies, with the private sector, and with the State et al. Understand/agree upon an "incentive" that promotes and maintains collaboration among agencies.

- Clarify a commitment by both DOE and EPA as to the kind of collaboration, which would facilitate positive interaction and fruitful cooperation.

- U.S. DOE should work with its partners to continue to obtain other perspectives on the Vadose Zone Roadmap and vadose zone problems.

- Make sure DOE needs don't get overshadowed in partnering with larger agencies, although DoD and private sector interests may be great in this effort.

- Consider the DOD model identified by U.S. EPA Region IV as a guide to developing a new partnership with DOE. All agencies must agree to the scope of the partnership effort, regulators must be involved early on in the process, and any test cases must be developed in concert with States.

- DOE should partner with other Federal agencies including Interior (e.g. BLM and NRDA) Agriculture, DoD, and NASA. U.S. EPA felt that they could work closely with DoD and DOE to design pilot studies that would be beneficial to all regulatory groups and other users and sites as well.

- The need for agency coordination was stressed, including making the best use of limited resources, interfacing more with regulators, identifying opportunities to bring DOE into the regulator's project team, and to utilize and attend DOE training courses.

- Regulators desire that U.S. DOE and other agencies provide more information about training opportunities that would also help close the gap between regulators and DOE.

- What collaboration between U.S. DOE and U.S. EPA is truly possible – how can this be supported, and what steps are required?

- Need to develop input to the implementation plan before DOE decides on its own how to progress with the project.

- How will the effort for Vadose Zone Roadmap be implemented between the different agencies, and under what time frame – should this be identified in the roadmap and/or the implementation plan?

4.2.2 State Partnerships

- Teaming of multiple agencies is very important; trust must be improved between the states and DOE.

- Recognize ECOS concern that states will inherit sites over the long term requiring high levels of maintenance. The states' limited resources call for increased cooperation.

- Identify a reasonable means of developing a more acceptable partnership between states and the Federal government.

- The States have different concerns and drivers than the Federal government – how will these be figured into the process?

- The role of State governments must be considered significant in defining the strategy within the Roadmap and implementation plan.

- States would like to have better information on tools, costs and deployment requirements for the technologies that would be used to address issues in the vadose zone – states have limited resources and need a repository of information with easy and understandable access.

- Need concrete plans to continue joint efforts among all Federal and state agencies to work toward resolution of complex vadose zone and related problems. Agency cooperation is currently minimal.

- What are some innovative approaches for the short-term? What can make the partnerships come together more quickly?

- Identify a means of developing a more acceptable partnership between states and the Federal government. Outline clear rules and guidelines for states to follow in the partnering process.

- Engender an effort towards interagency partnerships and promote collaboration between Federal, state, and local governments, as well as universities. Explore methods to integrate universities so that they can become important partners in the VZ efforts**.**

4.2.3 Scientific and Technical Partnerships

- How can we truly implement a multi-agency response to vadose zone science? Identify a better way to bring scientists and engineers into these efforts.

- How much of the "home grown" resources available at states are being used, i.e. local universities and experts?

- Consider a broader peer review process and multi-agency discipline, risk assessment, modeling, and interdisciplinary approach in future reviews of the Roadmap.

- We need to get researchers who are currently involved with the vadose zone to become more involved in solving the problem rather than only studying it. In addition, those academic researchers who are not currently involved in the Vadose Zone Program need to get concerned about vadose zone contamination.

- How can state geologists get involved in project? Will there be outreach to state geologists?

- Encourage the creation of unsaturated zone teams (e.g. groundwater modeling design teams at U.S. DOE facilities). These teams have been a successful concept at the Savannah River Site Consider combining such teams with the unsaturated modeling with GMS.

- Need to have a better understanding of the partnering role of technology developers in how the Vadose Zone Roadmap is developed and implemented. Explain in the implementation plan and have a plan for action.

- Need to continue to improve the customer, stakeholder, regulator, user interface with science and technology community. How can the principals build on this start?

- Share an inventory of active vadose zone researchers and research projects; hold a scientist-to-scientist workshop

- Prioritize vadose zone research and sponsor joint research projects; seek cooperative research between entities.

- States do not have to be involved in the research except for peer review.

4.3 Information Availability and Public Involvement

4.3.1 Improve Data Availability and Information Exchange

- How to safeguard the public is key to any decision-making – collaboration between a broad spectrum of interested stakeholders is essential, including establishing appropriate means of communication.

- There is a clear need for better communication on the threats to public health and the environment for states to provide to their constituency – how is this communication process developed?

- Technology gaps could be improved with new information transfer approaches/systems including providing GIS for project managers and stakeholders.

- Intent of the PSE (Problem-Solving Environment) is that it be used by a wide range of professional (researchers to stakeholders) to enhance communication.

- We need to have a better understanding of the critical problems that are faced in the vadose zone and by those who are working across the complex to address the problems.

- Develop a better communication/data retrieval process as an outcome of this project.

- Communications between researchers, implementers, and stakeholders must take place as science advances – suggest that this is a major purpose of the Roadmap.

- Improve database and repository for relevant climactic weather data.

- Data should be part of the "public trust". It should be in layman friendly format and accessible, which makes it more likely to be institutionally shared.

- All states agreed with the need for not only regular and timely information but also technical assistance.

- There needs to be consistency in flow of information to different sites and compliance programs and requirements.

- A suggestion was made to establish a web site for communication between the Vadose Zone Roadmap researchers and end users.

- We must have a communication network follow up on the Vadose Zone Roadmap discussion, and it must link to larger stewardship groups.

- How could one set up a communication network between stakeholders?

- Data management is key for any successful science and technology effort – there should be a central repository established to keep the information that is gathered and collected over the course of the initiative. The repository should be easily accessible to stakeholders and tribal members.

- Identify where/what are the best sites/entities for the data repository? Are universities a viable outlet?

- Consider science-to-science workshops to improve communications and identify opportunities to improve information exchange of relevant information from other groups (e.g. NIH).

- Develop visualizations for presentations to distribute information to a large array of stakeholders.

- Develop a presentation that demonstrates the increasing dependence of the American public on groundwater and drinking water and limited and diminishing supplies.

- Ensure that the public has access to data and that tools for access are readily available and easy to use.

4.3.2 Improve Stakeholder Involvement

- Make the roadmap useful for stakeholders, not just researchers. Keep the process open to stakeholders through data accessibility and participation opportunities. The public should be involved in decision making.

- Communications with regulators, researchers and stakeholder communities need to be improved. Communication at the project level is as important as higher up. How can there be a link with other EPA offices to offer more roundtable discussions?

- Communicating these vadose zone research needs to affected stakeholders is critical for the consistent and all-encompassing application of science and technology. This needs to be done early on in the process and be continuous and dynamic.

- Need to better identify and state the compelling need to all types of stakeholders for such research

- Explore the totality of partnerships beyond scientists and regulations, i.e., is there a place for public involvement?

- Develop a targeted communication plan specifically directed to Congress, the scientific community, environmentalists, and industry.

- No regulators or members of the public were on the 62-member Roadmap team. Involve contractors, customers, regulators and engineers as implementation moves forward.

- The implementation "team" for the Vadose Zone initiative needs to be inclusive for creation of the implementation plan. An initial action of the team would be to "sift" through the state of the art in technology and applications to needs to see where there could be the best fit – in the near and long term.

- EPA wants to work with DOE to improve communication with public.

- Stakeholders desire meeting summaries to be shared among stakeholder groups.

- DOE should reach out "further" to the State and Tribal Governments Working Group (STGWG), the Environmental Council of the States (ECOS), the Southern States Energy Board (SSEB), Interstate Technical Regulatory Council (ITRC), and the Western Governors Association (WGA) to gain support for the Vadose Zone effort.

- Consider other organizations like EPRI, GRI, Municipalities (ICMA) and API to identify other potential partners who share Vadose Zone problems and would benefit by the research effort.

- Identify issues outside the DOE complex that may benefit the DOE and other organizations and help leverage other Vadose Zone efforts.

- What other organizations (e.g. DoD, private sector) and non-governmental groups/individuals should be involved in the Roadmap effort and receive its benefits, and how can we best secure their participation?

4.4 Science and Technology Issues

4.4.1 Understanding Basic Processes and Gaps in Knowledge

- Elements of greatest interest to EPA research are hydrologic processes, chemical and microbiologic processes.

- Greater focus is needed on groundwater as receptor and groundwater/surface water interactions

- Will vadose zone research address consolidated and unconsolidated media? Complex fractured and karst subsurface needs more support.

- Establish the importance of the capillary fringe with respect to flows and containment migration.

- Identify and support training opportunities in physical, microbial, biological and chemical characteristics and their relationship to fate and transport.

- Major needs -- understanding basic processes, barriers, groundwater remediation and access technologies

- Need to have a commitment from U.S. EPA and U.S. DOE to summarize all research efforts at U.S. EPA, U.S. DOE and others. Need to share with stakeholders in Phase I how the state-of-the-art will be bridged and gaps filled.

- Identify vadose zone impacts related to storm and other weather events (e.g. geological bath tub effect and environmental data relationships).

- Implement a quantification method for uncertainties.

- Encourage the use of field sites throughout the U.S. DOE complex, etc., in addition to concept of bench scale studies; e.g., regional geology, geochemistry, and climate. Consider adding information on bench scale studies to the Roadmap and/or implementation plan for specific timeframes over the 25-year period.

- There appears to be a lack of emphasis on the upper three meters or so of the vadose zone, especially with respect to the use of unsaturated material to provide long-term isolation of waste material. Though the specific numbers are not at hand, a large percentage of the DOE low-level waste, mixed low level waste, and tailings material will be disposed of through one of several shallow-land burial technologies. For example, the Area 5 RWMS at Nevada Test Site, and the E-Area Burial Grounds at Savannah River Site represent disposal areas on opposite sides of the meteorological spectrum. Though the sites have very different depths to groundwater, proximity to off-site receptors, and potentially different exposure pathways, both rely on processes occurring in the upper several meters of soil to isolate waste from the environment. It is not apparent from the Roadmap where an appreciation for these processes is described, or how they will be further studied. Given the obviously higher costs associated with disposal in deep geologic repositories or in deep boreholes (e.g., the Greater Confinement Disposal {GCD} boreholes at NTS), it would appear that shallow land burial disposal will be used for the foreseeable future. Thus, those processes (vapor flux, evapotranspiration, etc.) that significantly affect water movement in the cover material, above the stabilized waste, should be considered in future assessments of research needs.

- Research Priorities for Chemical Properties and Processes (The third bullet under Year 2010): Some clarification or correction is needed. An evaluation of regulatory requirements for cleanup and detection of contaminants/constituents would apply to most environmental media requiring detection capabilities in the ppm or even the ppb range. Any development in monitoring capabilities must be done with an understanding of existing performance criteria if the data is to be used for compliance purposes. If it has applications for better understanding of vadose zone phenomena, then a lower detection capability may be fine. But for compliance monitoring there needs to be some confidence that a prototype will reach detection performance criteria in a reasonable amount of time if there is to be support at DOE and other Federal facilities programs for funding their development or using them.

- Determining the kinetics of ion exchange and surface complexation reactions on mineral surfaces and colloids" may need to be a research priority that is addressed sooner than the Year 2010. There is a growing body of evidence from a number of Federal facilities that some reactive barriers (a remedial strategy that has gained acceptance in recent years) for groundwater and spring discharges have been constructed without an adequate understanding of these properties and phenomena.

- There could be more emphasis on the study of coupled processes as fundamental to the understanding of flow and transport through the unsaturated zone. Within the

Roadmap, the study of coupled processes falls under the Models and Simulation heading. Just as there is a need for experimental confirmation of fundamental physical, chemical, and biological processes, there will also be a need for experimental confirmation of these processes when they are coupled. Conducting experiments more complex than those currently undertaken will additionally serve another purpose: new and different phenomena than are currently unrealized will be observed, measured, and eventually incorporated into models.

- A number of people indicated that there was no compendium by DOE, U.S. EPA or other agencies, that provided a baseline for Vadose Zone information (e.g. research). Being unable to establish a baseline suggests that the gaps in knowledge to be filled are unknown. Everyone agreed that a secondary companion book to the Roadmap on existing technology affecting Vadose Zone, Vadose Zone research, and lessons learned was essential. It was acknowledged that if the Roadmap were to bring regulators from the state of the art to the state-of-the-knowledge, the compendium was critical.

4.4.2 Site Characterization, Modeling and Data Analysis

- What are the most cost-effective methods to characterize sites?
- How can advanced instrumentation be applied to groundwater, soils and sediment characterization?
- What innovative techniques, instruments and tools are available?
- How do the emerging models fit into the 2006 closure plans?
- Identify current state-of-the-technology in the oil industry that can be replicated for the vadose zone.
- A site impact assessment model could help with serious problems and threats. Most important problems need to be addressed first.
- Modeling is important. For example, interbeds have lateral flow, yet main flow is downward. How do you characterize vertical features?
- How soon will research results determine which models are most effective at the sites?
- Open the source code in modeling to allow for transparency.
- Models need to be scaled and run at different speeds.

- Are QW/VT models accurate enough to make decision about long-term monitoring?

- Need the roadmap and related implementation plans and technical support to address uncertainties in modeling, and in particular with regard to mobility of metals.

- Previous DOE subsurface models indicate no problem; now Roadmap identifies significant problems. Inconsistencies need to be resolved.

- There should be an agreed upon process for evaluating the assumptions of the models when making remediation and regulatory decisions that involve stakeholders.

- The decision process needs to involve the stakeholders collectively in how to deal with the modeling uncertainties through the Roadmap implementation.

- One of the most critical areas for study should be in the area of characterization (economies of scale could be used with the interpretation of existing geophysical logs, supplemented by additional logging)

- Value of Data Comment: The Roadmap probably does not capture the state-of-the-art in this field. Capability and systems exist now to "convey to end users at what cost, data density, and level of investment (is) needed to reduce uncertainty" (a Year 2025 research goal); although in some cases these systems or methods may be more qualitative than desired. It might be better here to clarify at what scales uncertainty reduction is needed, and to add, "to compare costs invested and risk reduction obtained." It is recommended that a survey be made of the state of decision support tools for characterization in particular. For groundwater contamination, DOE/NV has made effective use of "Data Decision Analyses" to make choices about additional characterization for the Project Shoal Area and the Central Nevada Test Area (CNTA). In the case of CNTA, DOE/NV recently presented a case to the State of Nevada for an adaptive monitoring program rather than additional characterization per se as being the next step forward for subsurface contamination.

- Modern Numerics Comment: The terms "error" and "uncertainty" seem to be used interchangeably in this section, which might be a mistake. An error could be made in using the data in the face of uncertainty, but it is recommended not to treat the terms the same. In addition, a certain portion of uncertainty in vadose zone systems will not be reducible because of variability and randomness of processes. A distinction between these terms should be communicated to the stakeholders.

4.4.3 Contaminants and Risk Reduction

- How can existing risk management approaches be made more effective? What new approaches can be applied to recalcitrant problems?

- Criteria should include risk reduction and return on investment.

- Regarding risk reductions, numeric decisions are not too useful, and narrative descriptions are more viable.

- Inventory the most critical contaminants at each site. Address mass balance of most mobile radionuclides that pose the greatest risk: Technicium-99, Iodine-129, Chromium, Uranium, Carbon Tetrachloride, Strontium-90, possibly plutonium.

- Prepare a toolbox that displays why the vadose zone is an important component of the pathway for risk analysis at not only DOE sites, but also for MNA, Brownfields, etc.

- Lastly, it may be worth adding that the Roadmap does not include surface or near surface contaminant issues, where the vadose zone itself poses potentially immediate risk to human health and the environment. The bigger regulatory issue with these contaminated soils (and one germane to the Soils Project at DOE/NV) is the establishment of risked based cleanup standards under CERCLA or under the AEA for radionuclides, or for hazardous substances under RCRA or CERCLA.

4.4.4 Improvements in Monitoring and Adaptive Management

- Vadose zone research will lead to better predictability and analysis, better remediation, and identifying new monitoring approaches and resource requirements.

- DOE has not been consistent in their environmental monitoring approach due to the imbalance in knowledge and experience of the agency personnel.

- Interpret how stakeholders and tribes can be engaged in the long-term in research planning and implementation. Identify key gaps/modeling uncertainties that should be considered in developing long-term monitoring programs.

- Residual contamination will still exist after cleanup, so effective, low cost monitoring techniques will be needed for LTS. Changing scale will be necessary for long-term monitoring. Scale affects how we look at problems and how improvements can be made.

- What are the "early warning" VZ technologies available (or that are on the horizon) that can be deployed under extremely light state monitoring and remediation budgets?

- Will Federal and state regulations support an imperfect beginning in VZ monitoring?

- Developing a new generation of microscopic sensors should also include developing effective methods of deploying them. For example, microsensors hold a promise of monitoring more intact vadose zones. But if delivery systems disrupt soil properties

in the vicinity of the sensors, then some of the value of the microsensors is lost. Delivery systems for monitoring and characterization are discussed later in the document, but it is recommended that they be more closely linked in this document.

- A discussion on page 5 describes options under RCRA to monitor the vadose zone in lieu of groundwater monitoring. Here the issue is not so much regulatory as it is the confidence of regulators and other stakeholders in accepting vadose zone monitoring without groundwater monitoring. Even where vadose zone monitoring is conducted, regulators and stakeholders may still be reluctant to forgo groundwater monitoring altogether. However, even in such situations, from a Long-Term Stewardship (LTS) perspective, there is probably value in DOE monitoring the vadose zone to detect problems before they cause impact to groundwater.

- Assuming that complete site remediation may not be technically feasible at many sites, there will be an increase in the use of the closure-in-place options that will require more investments in long-term stewardship and monitoring. This may be especially pertinent at sites located inside large government compounds, like SRS, Hanford, NTS, and INEEL. In this case, long-term monitoring (LTM) will be a significant issue in the disposal program, assuring stakeholders and DOE that waste isolation techniques are preventing releases, that the extent and severity of existing contamination is not worsening, and that active or passive remediation schemes are effective. Though the Roadmap does include monitoring network design and sensor development (Tables 13 and 14, respectively), the research priorities do not include the need to study sensor accuracy, reliability, lifespan, and the effect of sensor failure on monitoring programs. For example, how are sensor lifespan and failure incorporated into design of monitoring systems and reduction of uncertainty during LTM programs? If LTM programs are implemented in the near future, regulators, DOE end users, and the public will heavily scrutinize these sensors to be sure they work efficiently and effectively. One suggestion would be the creation of two or more well-characterized testing centers, for studying the benefits and limitations of sensors and emplacement techniques either currently off-the-shelf or under development. The centers could be located in two or more distinct geographic regions, with sufficient footprints to accommodate field scale experiments. Results of the experiments could be incorporated in LTM programs as they evolve from near- to long-term.

- Comment on “determining the level of scientific certainty required to make good decisions [on site closure]”: While determining levels of acceptable certainty and uncertainty is definitely not the purview of the research community alone, we believe that establishing methods for evaluating acceptable uncertainty and scientific management of disposal sites in the vadose zone, in the face of uncertainty, definitely is within this purview. Much of the research proposed is this roadmap can occur at sites being closed by DOE, in parallel with monitoring data being collected at them. It would then be important to consider these closed sites when the research results are implemented. For example, what adaptive management approaches should be taken at

sites where final closure decisions occur after new research findings? Are there areas of such high uncertainty for some sites that closure should be delayed (this question is important in determining the prioritization of the research)? This will not be an easy strategy to sell to stakeholders, nor to Congress, but one that deserves consideration. Vadose Zone science would be a major component of the justification. A pilot adaptive or phased closure project during the implementation stage of the roadmap could be established to evaluate incorporation of site monitoring results and additional site investigations into the site remedy over time.

4.4.5 Remediation Technologies

- The Roadmap must provide a linkage to the regulatory remedial process, and this is not sufficient in the current Roadmap.

- Who at each site will receive vadose zone research information and what will be their input into the remediation process?

- What technology is most needed to support the short-term regulatory decision process?

- Remediation actions need to be taken now; research shouldn't overshadow actual cleanup. There is too little focus on remediation/containment approaches.

- The Roadmap needs to be tied more closely to remediation goals and the groundwater. There is a strong need for better screening tools (and better modeling of boundary conditions) that will help to integrate and define movement through the Vadose Zone to the groundwater, and the relative remediation target/schedules, etc.

- Make the roadmap keyed to remediation and closure of activities. Determine whether there will be a remediation roadmap?

- Need to better relate the Vadose Zone roadmap to the regulatory compliance milestones, priorities, and most importantly “available discretion.”

- Define opportunities and protocol for active and passive remediation such as soil vacuum extraction and barometric pumping. What, why and when is the most appropriate time to transition among the technologies?

- Improved support needed in identifying the interim methodologies. Prioritize technical needs from a regulator standpoint.

- Develop a process for making use of new science innovations and methodologies in the short-term. Identify the barriers to technology development and deployment.

- U.S. EPA is willing to consider/review regulatory flexibility, to deploy such technology on an interim basis that does not meet the original remediation goal.

- Identify technologies and information system that adequately provides background (lessons learned) for technologies that are also not currently being used at SRS and at other sites – define the potential benefits and risks.

- How quickly can new technologies be implemented to fill the technology gap and at what cost can these be accomplished?

- Need to better understand the present technologies that are already available rather than continuously developing new technologies.

- Define when the science would be completed on natural remediation processes (for near-term, mid-term, and long-term) to advance the regulatory decision process in this area.

- Application of state-of-the-art technologies that already exist – Can they be "retrofitted" to address what is known in the "here and now"?

- There need to be near term "winners" – to show that there has been progress made – this ties in with the short term need application- short term wins must be stressed. If there are economies of scale or retrofitting capability of existing technologies, there should be an effort to apply them now.

- Define how much cleanup is enough with regard to when the "switch is turned off." Have we clearly defined what is possible?

4.5 Regulatory Issues

4.5.1 Compliance Needs of Regulators

- A key aspect of the vadose zone research is that the results will help to protect national groundwater resources.

- U.S. EPA and others were concerned that the Roadmap was merely an opportunity for DOE to delay compliance. Incorporate compliance issues into the Roadmap.

- Understand the relationship, impacts and needs of states in the DOE Roadmap; where might the vadose zone efforts impact the regulatory agencies, and how best can DOE involve those agencies and assure that the Roadmap effort considerate of the regulatory requirements?

- Roadmap and its related research should provide more confidence in future decisions, whether for remediation or monitoring.

- Given the long-term compliance schedules, how can the Roadmap or its implementation be justified? Current performance is not satisfying the public or regulators.

- Garner a better understanding of state agency/ EPA positions regarding new technology deployment within existing REPA/CERCIA constraints.

- It is difficult to understand why the roadmap is really a 25-year schedule. How can it effectively support the regulators given the long time frames with minimal deliverables?

- Why should states and particularly the regulators be so concerned about the vadose zone? Aren't their overarching concerns clearly identified in the Vadose Zone Roadmap?

- Need to learn more about the regulators' priorities and how the science evolution can interface their needs.

- Need to better understand the regulators' perspective on strategic planning versus near-term decision making.

- There appeared to be very low regulatory representation on the Executive Committee. Roles and responsibilities should be defined in the implementation plan, that is, how to involve the regulators to a greater extent.

- Consider that at times it may be necessary to choose a detour from the Roadmap to solve an immediate problem, even where it may not fit perfectly with the long view for vadose zone.

4.5.2 Site-Specific Recommendations

- The Roadmap should provide specifics for describing by site, their R&D efforts and implementation plans.

- Provide research on site-specific differences due to environment/geology variation.

- Identify major problems at specific sites and do 5-10 year pilot project or demonstration, including public involvement.

- Roadmap should drive some of the site evaluations and help with tech/remediation cleanup challenges.

- Infrastructure piece in roadmap should define field campaigns so roadmap reflects real problems at DOE sites.

- Address common linkages between DOE sites.

- Research people need to be tied in with site people who are dealing with the practical problems in the field

- What is the interface between surface water and groundwater issues – 95% of drinking water comes from groundwater in **Idaho** making contamination of the aquifers the highest priority

- **Paducah, Kentucky** has issues of plume migration, mingled sources, and uncertainty in characterization of the vadose zone. They desire that the best models are identified and used, that they apply existing guidance, and are assured that all agencies have the same priorities for remediation and resource utilization. There are three primary issues that **Kentucky** faces and they include: narrowing down and use of appropriate technologies (e.g. infrastructure problems), worker safety issues, and cost-effective approaches that protect health and allow for pilot testing. **Kentucky's** focus has not been on modeling but on cleaning up. They are concerned that if the Roadmap timeframes are so extensive as to when critical new knowledge is provided, it may not be as helpful for their immediate decision timeframe.

- **South Carolina** recognizes that better predictive models are required. Further, as with most states, in-house expertise is minimal. South Carolina stressed that any new models or approaches must have the approval of U.S. EPA to assure the state that they have received the appropriate national peer review and are accepted as readily available. South Carolina acknowledged that they work closely with their **Savannah River Site** and have developed a positive working relationship, which has helped to advance the science effort. They have identified positive experiences, and indicated that their coordination with stakeholders was vital.

- Gain increased understanding of how the Roadmap work applies to **Savannah River** Site (and other sites) and in particular define how the effort will enable reducing time and cost to achieve remediation.

- Groundwater at **Hanford** has dropped and measuring units are drying up. Monitoring system should be retrofitted using Roadmap funds.

- Monitoring in the vadose zone should be established in the tank farms and in the waste sties at **Hanford** and included as part of the Long Term Stewardship plan. In addition, continuation of vadose zone field transport studies and the focus on carbon tetrachloride at the **Hanford** site is critical.

- Speaking as a State of Washington regulator, we felt the interest was high on the Vadose Zone Roadmap. Many lessons learned can be culled from experiences thus far at the **Hanford** Reservation –for example, through the **Hanford** vadose zone road mapping process, there was very extensive public involvement. Stakeholder involvement will be critical to any success.

- Here and elsewhere, the question of regulatory oversight needs careful clarification, because some "regulatory gaps" exist in questions regarding vadose zone contamination. Most cases include existing vadose zone contamination resulting from releases from previously unpermitted facilities under RCRA. An example is the **Hanford Tanks** where, if a spill or other release occurred today, it would be regulated under the tanks provisions of RCRA. Uncertainty does exist in cases where spills occurred prior to the tanks being regulated. The contamination from these older spills could pose a threat to groundwater; when demonstrated impact to groundwater exists, DOE-RL has had to address sources of this contamination. But in other cases at **Hanford,** it is quite conceivable that, without demonstration of a risk, vadose zone contamination will likely be left in place.

- Another example is at the **Nevada Test Site** (NTS) and the eight other locations in the United States where underground nuclear testing was conducted. There is satisfactory agreement among regulators and DOE that remediating contamination in the vadose zone is technically infeasible. Instead, the focus is whether the vadose zone contamination poses at impact to groundwater.

- **Tennessee** focused on problems with remediation designs and compliance point issues. Like the other states and U.S. EPA, they expressed the concern that the Vadose Zone research effort not inhibit cleanup. Further, they expressed the concern that karst and tight clays at ORNL (**Oak Ridge National Laboratory)** add additional complications to the subsurface, and that any models developed need to recognize these conditions and have an appropriate caveat: Their primary focus is on long-term monitoring and natural attenuation.

- How does the Vadose Zone roadmap relate to the **Oak Ridge National Lab** site problems and other U.S. DOE sites -- how will this be addressed in the roadmap and/or in the implementation plan for the roadmap?

Review Comments from Oak Ridge National Laboratory (received August 20, 2001)

The mission of creating a roadmap for vadose zone must have been daunting. We applaud the team for their effort and accomplishment on this difficult task. Our understanding was that the team was not constrained by budget, schedule, or cleanup priorities. Thus, we assume that the roadmap should be comprehensive – perhaps to the point of overindulgence by investigators by including all processes and parameters. We also assume that the length of complexity of the document is at least partially a result of

trying to include everything. Our comments may seem somewhat harsh but they are intended to be constructive so that this important scientific issue is well described.

The complexity of the report and the short amount of time to pull together a comprehensive review were a challenge. The attached comments result from a review by several staff. We have not collated or combined them. Therefore, you may seem some inconsistent observations and concerns. This may be beneficial to you, however, since the public review will also result in varying points of view. Our review team consisted of hydrologists, geochemists, soil scientists, microbiologists, thermodynamicists, geophysicists, geologists, and remediation engineers.

Please contact Steve Kowall, KOWASJ@inel.gov for a copy of the **PDF File with specific ORNL Comments**